Appendix 2:

Bucktail Creek excerpts from:

CH2M Hill. 2001. *Aquatic ecological risk assessment, Blackbird Mine Site.* Final Report. Prepared for U.S. EPA, Boise, Idaho. Prepared by CH2M Hill, Denver, CO. August 27.

Report

Final Aquatic Ecological Risk Assessment, Blackbird Mine Site

Prepared for

United States Environmental Protection Agency Region X, Idaho Operations

Prepared by

CH2MHILL

August 27, 2001

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Appendices

List of Tables

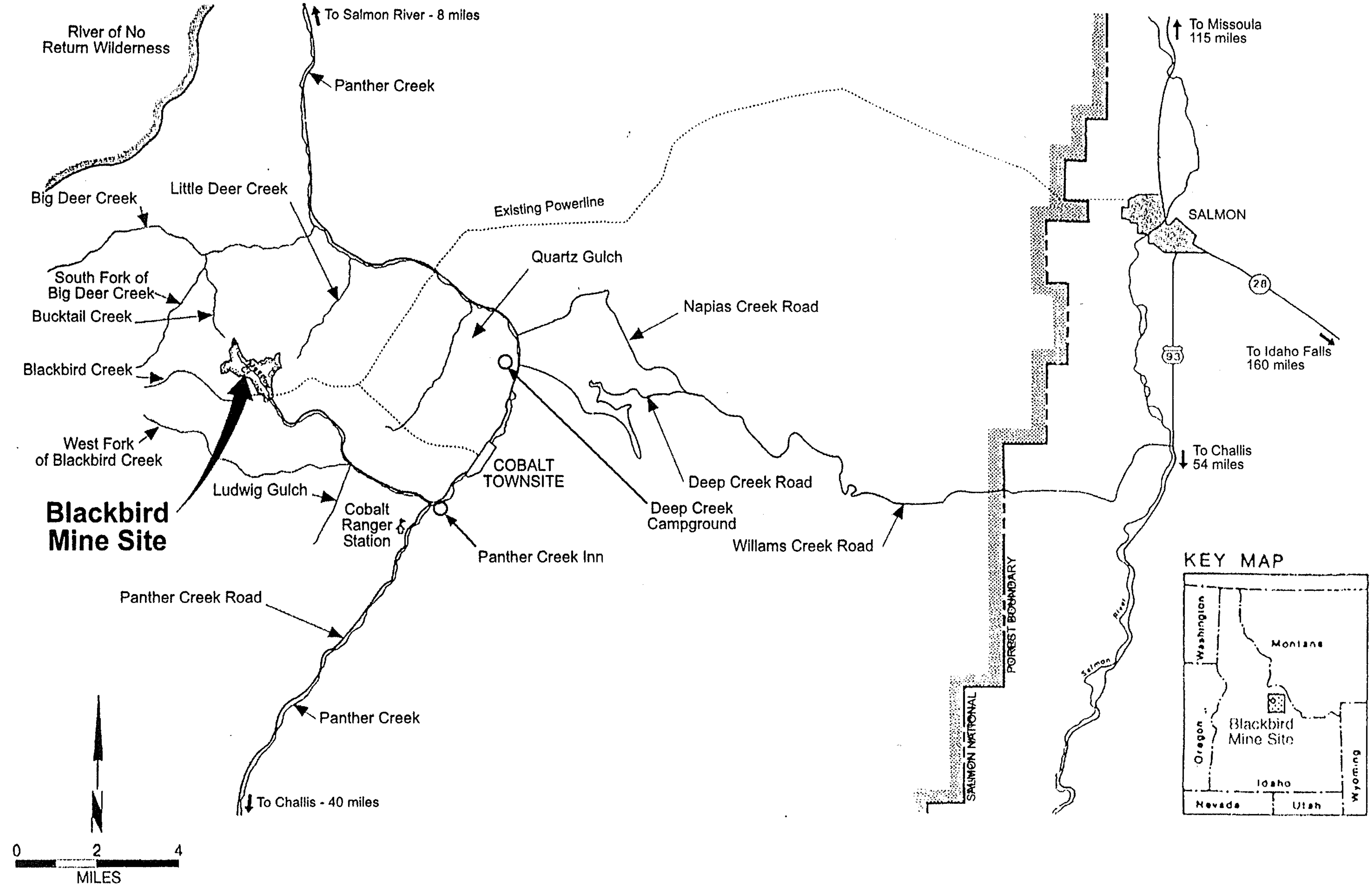
Executive Summary

This document presents the aquatic ecological risk assessment (AERA) for the Blackbird Mine Site. It follows the protocol developed by the United States Environmental Protection Agency (EPA) for performing an ecological risk assessment (EPA, 1992; EPA, 1998) and is consistent with the requirements for ecological risk assessment at Superfund sites (EPA, 1997). It focuses on identifying and evaluating risks to the aquatic ecosystems of Blackbird Creek, Panther Creek, Bucktail Creek, South Fork of Big Deer Creek, and Big Deer Creek, Lemhi County, Idaho, in support of risk management decisions.

Past investigations at the Blackbird Mine Site by the State of Idaho, the U.S. Forest Service, the National Oceanic and Atmospheric Administration, and others, performed in part to support a claim of damages to natural resources, led to the conclusion that past and continuing releases of mining wastes produced by operation of the Blackbird Mine have resulted in unacceptable risks to ecological receptors. This resulted in decisions by EPA to prepare a Remedial Investigation/Feasibility Study (RI/FS) and to conduct nontime-critical removal actions (Early Actions) to alleviate or reduce continuing threats to human and ecological receptors. The RI/FS and the nontime-critical removal actions were governed by two Administrative Orders on Consent (AOC) between the EPA and responsible parties, the Blackbird Mine Site Group (BMSG). The AOC governing the RI/FS was signed in November 1994, and the AOC governing implementation of the nontime-critical removal actions was signed in June 1995. A separate Consent Decree was entered in September 1995 between the Natural Resource Trustees and the BMSG resulting from the Natural Resource Damage Assessment (NRDA) claims. The Consent Decree established natural resources restoration goals for Panther and Big Deer creeks.

The Blackbird Mine site covers approximately 830 acres of private patented mining claims and 10,000 acres of unpatented mining claims previously held by Noranda within the Salmon-Challis National Forest, 13 miles south of the Salmon River and approximately 25 miles west of the town of Salmon, Idaho (Figure ES-1). It is the site of a large copper and cobalt deposit. Mining activities began in the late 1800s, and continued sporadically until 1967. Since that time, additional exploration work occurred at the site from 1978 through 1982. Mining activity within the site resulted in about 14 miles of underground workings and a 12-acre open pit (Golder, 2001). In addition, graded roads, waste rock,tailing piles, and various impoundments occur within the area. Additional information is reported in Golder (2001).

The mine is within the Blackbird and Bucktail creek drainages, both of which ultimately flow into Panther Creek. Currently, since the implementation of the Early Actions, overland flows from the mine area into Blackbird Creek are largely contained and treated in the water treatment plant. Blackbird Creek discharges to its normal channel at a culvert downstream of the treatment plant, and flows approximately 3 miles to its confluence with the West Fork of Blackbird Creek. From this point, Blackbird Creek flows approximately 3 miles downstream to its confluence with Panther Creek. The headwaters of Bucktail Creek



SOURCE: ERT 1982

Figure ES-1
Location Map for Blackbird Mine Site

originate just below the Blacktail Pit. Early Actions resulted in capture of the upper section of Bucktail Creek for water treatment. It is then discharged into Blackbird Creek after treatment. Bucktail Creek flows northeast to its confluence with the South Fork of the Big Deer Creek, then into Big Deer Creek. Big Deer Creek ultimately discharges into Panther Creek (Figure ES-1).

This AERA is based on the assumption that current conditions and risks are best displayed by the most recent site data, which reflect improvements in water quality that may have resulted from the Early Actions. Information from past studies (in particular, the NRDA injury reports and site-specific toxicity testing) is used along with other literature in establishing the toxicity of metals in Panther Creek and its tributaries.

The AERA is organized as follows:

- Section 1.0 is the Introduction.
- Section 2.0 presents the Problem Formulation. This section includes the site description, identification of chemicals of potential ecological concern (COPEC), assessment and measurement endpoints, conceptual site model, and a summary of the data used in the risk assessment.
- Section 3.0 presents the Exposure Assessment, which describes the exposure to benthic invertebrates and fish.
- Section 4.0 presents the Effects Assessment, which identifies the physiological and toxicological interactions of the COPECs with the aquatic ecosystem and its inhabitants.
- Section 5.0 is the Risk Characterization, whereby the results of the Effects Assessment are linked with the Exposure Assessment to provide an estimate of risks to the aquatic environment.
- Section 6.0 contains the report's conclusions.
- Section 7.0 provides the bibliography.

Problem Formulation

The Problem Formulation step of the ecological risk assessment process summarizes the existing data and lays the foundation for the remainder of the risk assessment. This step includes developing ecological management goals, describing potentially impacted aquatic ecosystems, and identifying COPECs. For the Blackbird Mine site, COPECs are those metals that if released from the mine area are expected to adversely affect the aquatic ecosystem. Ecological receptors are also identified during the problem formulation process and assessment, and measurement endpoints are presented. Ecological receptors include salmon and other aquatic life that can be exposed to metals entering the stream system. Problem formulation results in the development of the conceptual site model (CSM), which outlines all potentially complete exposure pathways from the COPEC source to the ecological receptors. The CSM is presented in Figure ES-2.

Table ES-1 summarizes the management goals, assessment endpoints, and measures for the AERA.

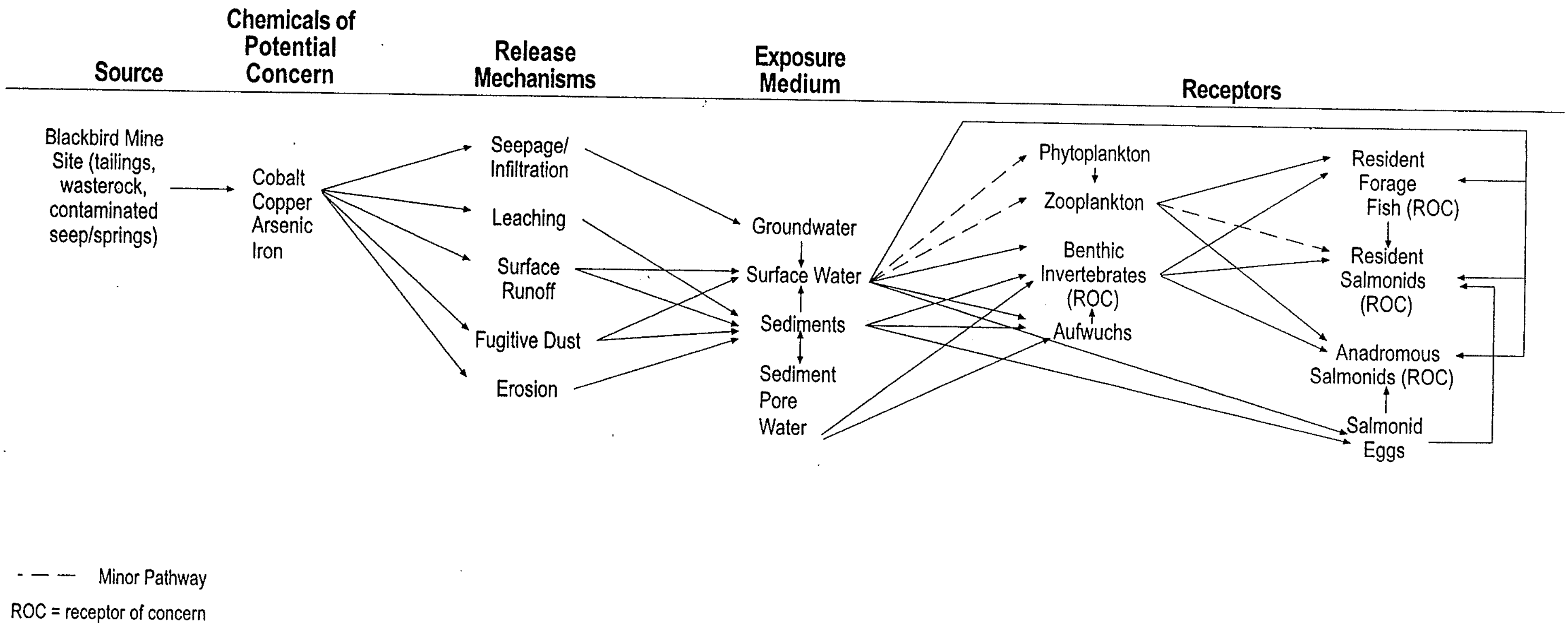


Figure ES-2
Ecological Conceptual Site Model-Aquatic Ecosystems
Blackbird Mine Site, Idaho

TABLE ES-1
Summary of Management Goals, Assessment Endpoints, and Measures for the Aquatic Ecological Risk Assessment

Management Goals	Assessment Endpoints	Measures of Exposure	Measures of Effect	Risk Hypotheses
1. Restore and maintain water and sediment quality, and aquatic biota conditions capable of supporting all life stages of resident salmonids and other fishes in lower Blackbird Creek below Early Actions	a) Survival, growth, behavior that would support habitat use, and reproduction by resident salmonids and other fishes and their food sources in lower Blackbird Creek. b) Survival, growth, behavior that would support habitat use, and reproduction by individual representatives of threatened and endangered resident salmonids and their food resources in lower Blackbird.	• Measured concentrations of COPECs in surface water • Measured concentrations of COPECs in sediment • Estimated concentrations of COPECs in benthic invertebrates	• Salmonid (all life stages) response to metal concentrations in surface water as documented by literature review • Chronic NWQC, which represent an acceptable metal concentration in surface water to which most aquatic species (i.e., 95 percent) can be exposed to without exhibiting adverse effects • Sediment Quality Benchmarks, which represent acceptable metal concentrations in sediments to which invertebrate species can be exposed without exhibiting adverse effects • Site-specific surface water – fish toxicity studies for the Blackbird Mine • Benthic macroinvertebrate community sampling data for the Blackbird Mine as compared to reference or background area data	• Concentrations of COPECs are present in Blackbird Creek at concentrations that are toxic (including effects on survival, growth, reproduction, behavior that would limit use of habitat or food sources) to salmonid and other fishes.
2. Restore and maintain water and sediment quality, and aquatic biota conditions capable of supporting all life stages of anadromous and resident salmonids and other fishes in Panther Creek	a) Survival, growth, behavior that would support habitat use, and reproduction by resident and anadromous salmonids and other fishes and their food sources in Panther Creek. b) Survival, growth, behavior that would support habitat use, and reproduction by individual representatives of threatened and endangered resident or anadromous salmonids and their food resources in Panther Creek.	• Measured concentrations of COPECs in surface water • Measured concentrations of COPECs in sediment • Estimated concentrations of COPECs in benthic invertebrates	• Salmonid (all life stages) response to metal concentrations in surface water as documented by literature review • Chronic NWQC, which represent an acceptable metal concentration in surface water to which most aquatic species (i.e., 95 percent) can be exposed to without exhibiting adverse effects • Sediment Quality Benchmarks, which represent acceptable metal concentrations in sediments to which invertebrate species can be exposed without exhibiting adverse effects • Site-specific surface water – fish toxicity studies for the Blackbird Mine • Benthic macroinvertebrate community sampling data for the Blackbird Mine as compared to reference or background area data	• Concentrations of COPECs are present in Panther Creek at concentrations that are toxic (including effects on survival, growth, reproduction, behavior that would limit use of habitat or food sources) to salmonid and other fishes.

TABLE ES-1
Summary of Management Goals, Assessment Endpoints, and Measures for the Aquatic Ecological Risk Assessment

Management Goals	Assessment Endpoints	Measures of Exposure	Measures of Effect	Risk Hypotheses
3. Restore and maintain water and sediment quality, and aquatic biota conditions capable of supporting all life stages of resident salmonids and other fishes in Big Deer Creek	a) Survival, growth, behavior that would support habitat use, and reproduction by resident salmonids and other fishes and their food sources in Big Deer Creek. b) Survival, growth, behavior that would support habitat use, and reproduction by individual representatives of threatened and endangered resident salmonids and their food resources in Big Deer Creek.	• Measured concentrations of COPECs in surface water • Measured concentrations of COPECs in sediment • Estimated concentrations of COPECs in benthic invertebrates	• Salmonid (all life stages) response to metal concentrations in surface water as documented by literature review • Chronic NWQC, which represent an acceptable metal concentration in surface water to which most aquatic species (i.e., 95 percent) can be exposed to without exhibiting adverse effects • Sediment Quality Benchmarks, which represent acceptable metal concentrations in sediments to which invertebrate species can be exposed without exhibiting adverse effects • Site-specific surface water – fish toxicity studies for the Blackbird Mine • Benthic macroinvertebrate community sampling data for the Blackbird Mine as compared to reference or background area data	• Concentrations of COPECs are present in Big Deer Creek at concentrations that are toxic (including effects on survival, growth, reproduction, behavior that would limit use of habitat or food sources) to salmonid and other fishes.
4. Restore and maintain water and sediment quality, and aquatic biota conditions capable of supporting all life stages of resident salmonids and other fishes in South Fork of Big Deer Creek below the confluence with Bucktail Creek	a) Survival, growth, behavior that would support habitat use, and reproduction by resident salmonids and other fishes and their food sources in the South Fork of Big Deer Creek. b) Survival, growth, behavior that would support habitat use, and reproduction by individual representatives of threatened and endangered resident salmonids and their food resources in the South Fork of Big Deer Creek.	• Measured concentrations of COPECs in surface water • Measured concentrations of COPECs in sediment • Estimated concentrations of COPECs in benthic invertebrates	• Salmonid (all life stages) response to metal concentrations in surface water as documented by literature review • Chronic NWQC, which represent an acceptable metal concentration in surface water to which most aquatic species (i.e., 95 percent) can be exposed to without exhibiting adverse effects • Sediment Quality Benchmarks, which represent acceptable metal concentrations in sediments to which invertebrate species can be exposed without exhibiting adverse effects • Site-specific surface water – fish toxicity studies for the Blackbird Mine • Benthic macroinvertebrate community sampling data for the Blackbird Mine as compared to reference or background area data	• Concentrations of COPECs are present in the South Fork of Big Deer Creek at concentrations that are toxic (including effects on survival, growth, reproduction, behavior that would limit use of habitat or food sources) to salmonid and other fishes.

TABLE ES-1
Summary of Management Goals, Assessment Endpoints, and Measures for the Aquatic Ecological Risk Assessment

Management Goals	Assessment Endpoints	Measures of Exposure	Measures of Effect	Risk Hypotheses
5. Restore and maintain water and sediment quality, and aquatic biota conditions capable of supporting all life stages of listed or candidate threatened or endangered[1] species in Panther Creek and its tributaries on an individual, rather than a population, basis	a) Survival, growth, behavior that would support habitat use, and reproduction by resident and anadromous salmonids and other fishes and their food sources in Panther Creek and its tributaries. b) Survival, growth, behavior that would support habitat use, and reproduction by individual representatives of threatened and endangered resident or anadromous salmonids and their food resources in Panther Creek and its tributaries.	• Measured concentrations of COPECs in surface water • Measured concentrations of COPECs in sediment • Estimated concentrations of COPECs in benthic invertebrates	• Salmonid (all life stages) response to metal concentrations in surface water as documented by literature review • Chronic NWQC, which represent an acceptable metal concentration in surface water to which most aquatic species (i.e., 95 percent) can be exposed to without exhibiting adverse effects • Sediment Quality Benchmarks, which represent acceptable metal concentrations in sediments to which invertebrate species can be exposed without exhibiting adverse effects • Site-specific surface water – fish toxicity studies for the Blackbird Mine • Benthic macroinvertebrate community sampling data for the Blackbird Mine as compared to reference or background area data	• Concentrations of COPECs are present in Panther Creek and its tributaries at concentrations that are toxic to individual salmonid fish listed as threatened or endangered under the Endangered Species Act.
6. Restore and maintain water and sediment quality in Bucktail Creek below the upper sediment dam capable of supporting aquatic macroinvertebrates so fish downgradient have an adequate food source	a) Survival, growth, reproduction of aquatic macroinvertebrates in lower Bucktail Creek.	• Measured concentrations of COPECs in surface water	• Chronic NWQC, which represent an acceptable metal concentration in surface water to which most aquatic species (i.e., 95 percent) can be exposed to without exhibiting adverse effects • Sediment Quality Benchmarks, which represent acceptable metal concentrations in sediments to which invertebrate species can be exposed without exhibiting adverse effects • Benthic macroinvertebrate community sampling data for the Blackbird Mine as compared to reference or background area data	• Concentrations of COPECs are present in Bucktail Creek at concentrations that are toxic to aquatic macroinvertebrates that could ultimately lead to reduction in food availability for salmonids and other fishes.

Exposure Assessment

Exposure analysis consists of quantifying the complete exposure pathways for the COPECs for each receptor exposed to each medium. The following three media are addressed by the AERA:

- Surface water
- Sediment
- Biota, as the dietary exposure pathway for salmonids

Surface water data were collected from various locations from streams in the Blackbird Mine vicinity during 1998, 1999, and 2000 for low flow and high flow conditions. The maximum dissolved surface water concentrations were used in the AERA as the EPCs as the basis of the risk estimates except for iron where the maximum total surface water concentration was used since the criteria for iron are based on total concentrations.

Sediment data were collected from various locations from streams in the Blackbird Mine vicinity during 2000. The maximum sediment concentrations on a dry-weight basis were used in the AERA as the EPCs as the basis of the risk estimates.

Benthic invertebrates are evaluated as a food source for salmonids. The dietary exposure pathway is evaluated by estimating the dietary exposure to salmonids from eating benthic invertebrates. Dietary exposure is estimated by predicting tissue concentrations in food items and estimating a daily dose with dietary ingestion rates. The dietary exposure pathway was evaluated for salmonids only.

Effects Assessment

The Effects Assessment consists of identifying the potential adverse effects that release of copper, cobalt, arsenic, or iron could have on aquatic receptors in the stream ecosystem. Toxicity information in the form of toxicity data reported in the literature for COPECs for surface water and sediments, site-specific testing (bioassays and other testing), and screening levels are reviewed for each metal. Toxicity reference values (TRVs) include the NWQC for surface water, EPA Region V (EPA, 1999) and NOAA Coastal Protection and Restoration Division (Buchman, 1999) benchmarks for sediments, and values derived from the peer-reviewed and site-specific literature. Following the discussion of each COEPC, a subsection is provided that describes a summary of the toxicity reference value (TRV) selection, and the benthic macroinvertebrate monitoring.

The TRVs are the values used in conjunction with data from the exposure assessment to perform risk characterization. The use of TRVs as the basis for calculating the Hazard Quotients (HQs), or ratio of the exposure point concentration to the appropriate TRV, is only one line of evidence that will be evaluated in this aquatic risk assessment. The TRVs were chosen after review of literature, the relevant and appropriate site-specific toxicity studies, and existing screening levels (ecological criteria and guidance) for the COPECs and media of concern (i.e., surface water and sediment).

Surface Water TRVs

The surface water TRV values are derived from the Idaho Water Quality Criteria (IDWQC) where available. Due to the considerable amount of information reviewed and integrated in developing the IDWQC, and its status as a legally enforceable criterion under the Clean Water Act, it was chosen as the most appropriate TRV for analysis of risks to aquatic life. The information from the literature and site-specific testing also supported the use of the IDWQC as the TRV. For cobalt, a state or federal criterion does not currently exist, thus the TRV was based on the literature and site-specific testing. Since there is currently no NWQC for cobalt, the TRV for the protection of aquatic life is based on cobalt toxicity to invertebrates. Data suggests that salmonids may be more tolerant of cobalt toxicity than invertebrates so a TRV protective of salmonids was developed for cobalt as well. Table ES-2 presents the TRVs for surface water.

TABLE ES-2
Surface Water TRVs

COPEC	TRV (mg/L)[1]	Source
Cobalt (aquatic life)	0.023	Chronic Tier II value (Suter and Tsao, 1996)
Cobalt (salmonids)	0.038	Weight-of-Evidence for literature and site-specific testing
Copper	varies[2]	CFR, 1999
	0.0035 at a hardness of 25 mg/L	
Iron	1	CFR, 1999

[1] Dissolved cobalt or copper in surface water, total iron in surface water
[2] The TRV for copper is corrected for hardness when comparing to site-specific data. See Section 4.1.5.

Sediment TRVs

A review of the benthic macroinvertebrate data indicates that the health of the benthic invertebrate community is improving. Because of the naturally high mineralization of the area and the possibility of adaptation of the benthic community to higher metal concentrations, it is possible that populations of benthic macroinvertebrates may survive at concentrations higher than indicated in the literature. It should be noted that survival alone or a species persistence at future sampling times does not indicate sustainability or community health capable of supporting higher trophic levels such as salmonids, as is outlined in the Ecological Management Goals.

The sediment TRV values are the TECs presented by MacDonald et al. (2000) or no effects levels from other sources. The sediment TRVs are summarized in Table ES-3.

TABLE ES-3
Sediment Toxicity Reference Value (TRV) Selection

COPEC	EPA Region V ESL (EPA, 1999) (mg/kg)	NOAA Squirt Table (Buchman, 1999) (mg/kg)	TEC (MacDonald et al., 2000)[3] (mg/kg)	Sediment TRV Selected (mg/kg)
Arsenic	6	6[1]	9.79	9.79
Cobalt	50	NA	NA	50
Copper	16	36[2]	31.6	31.6
Iron	NA	40,000[2]	NA	40,000

[1] Based on the Threshold Effects Level (TEL).

[2]Upper Effects Threshold (UET), no TEL was reported for these metals.

[3]The TEC is the preferred value. In the absence of a TEC, the lowest available value was used.

NA - not available

Risk Characterization and Determination

In the AERA, the potential risks to ecological receptors are predicted with a hazard quotient. The HQ is a ratio of the EPC/TRV for water or sediment exposure, or the ratio of the daily dose or intake for a receptor to the appropriate dietary TRV. An HQ in excess of 1 indicates a potential for risk, whereas an HQ below 1 indicates little potential for adverse effects. Table ES-4 summarizes the lines of evidence for risk determination. The overall risk determination for each creek is summarized in Figures ES-3 through ES-7. The sampling locations are presented in Figure ES-8.

Blackbird Creek

All the lines of evidence indicate that metals in Blackbird Creek has potential for adversely affecting the aquatic ecosystem (Figure ES-3). Surface water HQs for the protection of aquatic life and salmonids are consistently greater than 10 for copper and cobalt during high flow. During low flow, HQs are occasionally less than 10, but are generally also greater than 10 for both copper and cobalt. The sediment HQs were greater than 50 to 100 for arsenic, and concentrations were up to 38 times higher than background levels of arsenic. The sediment HQs for copper were nearly 50 to over 100; copper concentrations in Blackbird Creek were two to five times higher than background. Cobalt sediment HQs ranged from 7 to 10, and were greater than background by a factor of 2. The dietary HQs for copper and arsenic based on sediment uptake ranged from less than 1 to 9 for copper and less than 1 to 26 for arsenic. The benthic community data also indicate that there is the potential for adverse effects to the aquatic system since the downstream stations do not resemble the reference stations. However, there has been an improvement in the water quality and benthic community with the implementation of Early Actions.

TABLE ES-4
Summary of Lines of Evidence for Risk Description Mining Impacts

Lines of Evidence	Spatial	Temporal	Magnitude	Receptors of Concern	Future	Overall Assessment of Line of Evidence	Overall Weight
Surface Water Data	Each creek has fairly good coverage of each reach. HQs were developed for each location to determine the areal extent of risks.	Data collected during different flow regimes for three years and so are temporally representative of current conditions.	The magnitude of the HQs based on the surface water data range from less than one (no likelihood of adverse effects) to greater than one (likelihood of adverse effects)	Aquatic life (includes plants, invertebrates, and fish), Salmonids	Surface water concentrations may continue to improve. Significant storm events are likely to cause temporary increases in concentrations.	Surface water considered representative of site conditions and one of the more important lines of evidence in the risk assessment evaluation.	+++
Sediment Data	Fewer sediment sampling locations than surface water. South Fork of Big Deer Creek not well represented (one downstream location); Bucktail Creek has no sediment sampling locations.	Sediment data set limited to one event representing Post-Early Actions, so difficult to assess trends.	The magnitude of the HQs based on the sediment data range from less than one (no likelihood of adverse effects) to greater than one (likelihood of adverse effects)	Benthic invertebrates	Sediment concentrations may continue to improve as a result of the Early Actions. Storm events are likely to cause temporary increases in concentrations.	The limited data set is assumed to be representative of site conditions. Sediment concentrations for Panther Creek and Big Deer Creek appear to be within or only slightly above background conditions for sediments.	++

TABLE ES-4
Summary of Lines of Evidence for Risk Description Mining Impacts

Lines of Evidence	Spatial	Temporal	Magnitude	Receptors of Concern	Future	Overall Assessment of Line of Evidence	Overall Weight
Surface Water TRVs	TRVs are applied at all locations across the site.	Designed to represent chronic (≥4 day) exposures.	Fixed values with the exception of copper which varies based on hardness	Aquatic life; salmonids	The TRVs are applicable to current and future exposures.	The surface water TRVs combined with the surface water data are used to calculate the HQs. This is one of the most important lines of evidence for assessing potential effects. There is a high degree of certainty with the copper and iron HQs since these are based on the NWQC; therefore an HQ over 1 could lead to potential adverse effects. There is less certainty associated with the TRVs used for cobalt; therefore, there is less certainty as to whether an HQ greater than 1 would potentially cause adverse effects to the aquatic ecosystem.	Copper and iron TRVs are based on NWQC. Cobalt is based on a more limited data set. Cu – +++ Co – ++ Fe – +++
Sediment TRVs	TRVs are applied at all locations across the site.	Represent chronic exposures.	Fixed values represent concentrations below which adverse effects are unlikely to occur.	Benthic invertebrates	The TRVs are applicable to current and future exposures.	HQs based on the sediment TRVs are likely to represent levels for *de minimas* potential for adverse effects based on impacts from the Blackbird Mine as all are below site-specific levels associated with adverse effects in laboratory toxicity tests. TRVs for sediments are below background UTLs for COEPCs except for cobalt background UTLs for Panther Creek and Big Deer Creek.	Copper and arsenic TRVs are based on TECs. Cobalt and iron are based on a more limited data set. ++

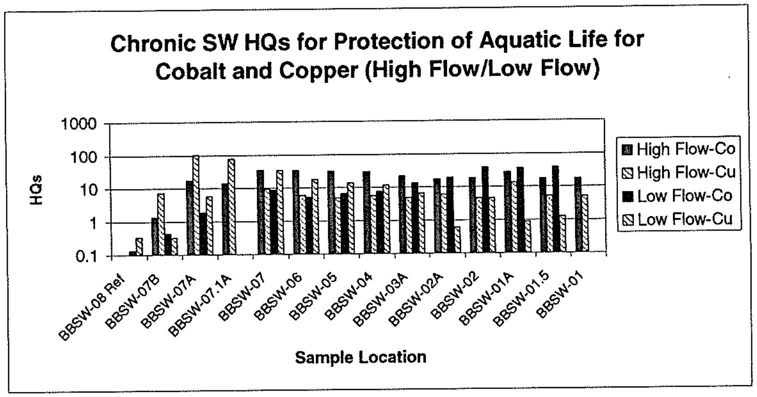
TABLE ES-4
Summary of Lines of Evidence for Risk Description Mining Impacts

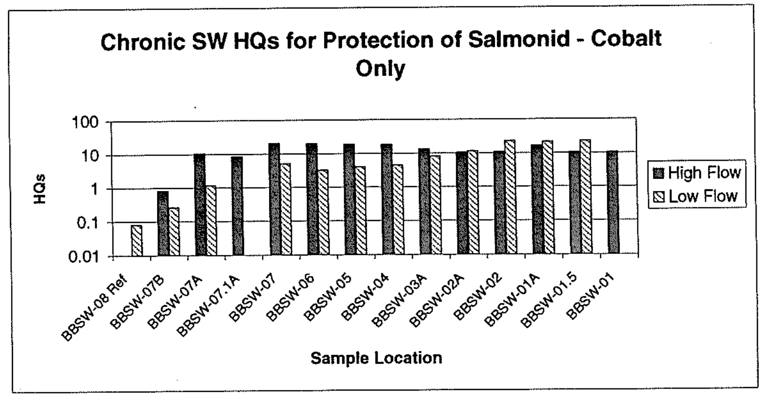
Lines of Evidence	Spatial	Temporal	Magnitude	Receptors of Concern	Future	Overall Assessment of Line of Evidence	Overall Weight
Sediment Background	A background value that represents pre-mining conditions is difficult to establish. Data from different studies were combined to obtain a statistical estimate used for background.	Data collected over a period of years; best estimate of pre-mining conditions.	Fixed value based on large dataset.	Benthic invertebrates	The UTLs are not likely to change as they are based on a large dataset.	HQs that take into account the background levels are more representative of the potential for adverse effects to the aquatic ecosystem due to mine related impacts. However, it is difficult to ascertain what pre-mining background conditions would be. Background UTLs estimated for Panther Creek and Big Deer Creek are likely to be underestimated (therefore overestimating risk) because affects due to mineralized contributions are not included in establishing background UTL.	+++
Benthic Community Data	Sampling locations are limited to sediment sampling locations.	There are three years of Post Early Action data by which to determine a trend. Given the variables that can affect benthic communities, this is considered limited temporal coverage.	Range of the various metrics varies depending on metric. In general, downstream metrics are lower than reference areas.	Benthic invertebrates, Salmonids are indirectly affected by effects on dietary availability.	Future predictions are difficult to make given that the 2000 data indicate less improvement than the 1999 data. Impacts due to fire also complicate evaluations.	It is unknown whether the current benthic communities present along the various creeks would provide an adequate food supply to the salmonids. The benthic communities are beginning to look more similar to the associated reference station in Panther Creek. The benthic communities have also shown an improvement since the implementation of the Early Actions.	++

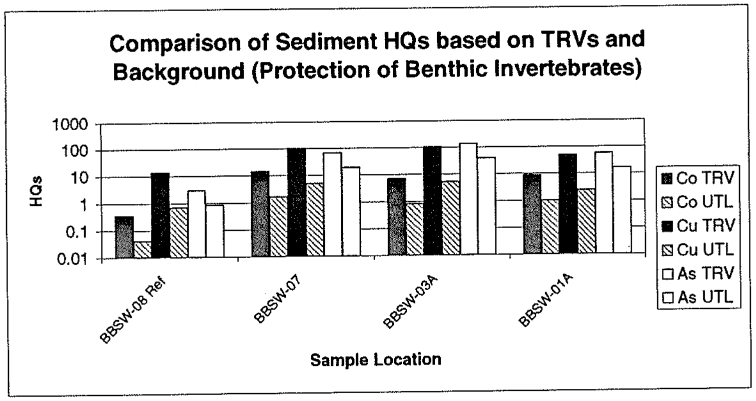
TABLE ES-4
Summary of Lines of Evidence for Risk Description Mining Impacts

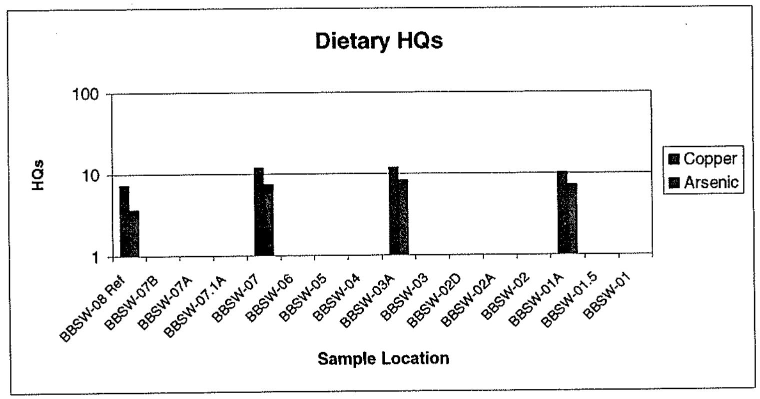
Lines of Evidence	Spatial	Temporal	Magnitude	Receptors of Concern	Future	Overall Assessment of Line of Evidence	Overall Weight
Dietary TRVs	TRVs are applied at all locations across the site where sediment values and modeled benthic invertebrate concentrations are available.	Designed to represent chronic exposures.	Fixed values.	Salmonids	The TRVs are applicable to current and future exposures.	HQs based on dietary TRVs are the most uncertain of all lines of evidence since dietary concentrations are modeled and not measured, and the TRVs are based on a limited dataset. These HQs suggest limited, but some potential for adverse effects for salmonids ingesting prey items.	Copper and arsenic TRVs are based on measured dietary no effects concentrations. Cobalt and iron could not be obtained. Cu – + Co – 0 Fe – 0 As – +

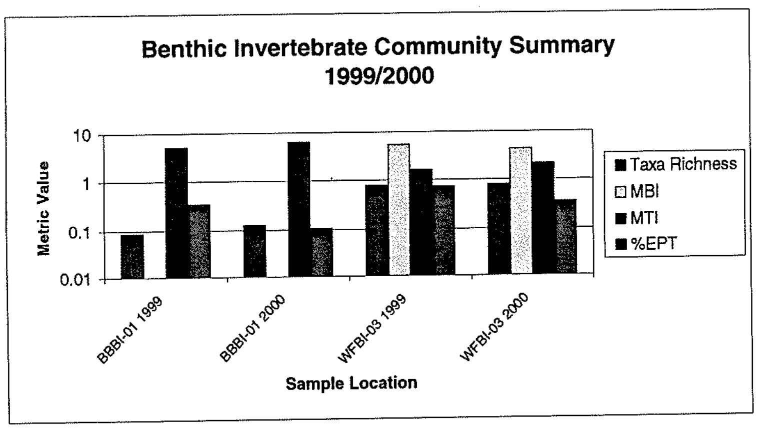
Figure ES-3
Summary of Risk Characterization for Blackbird Creek (2000)









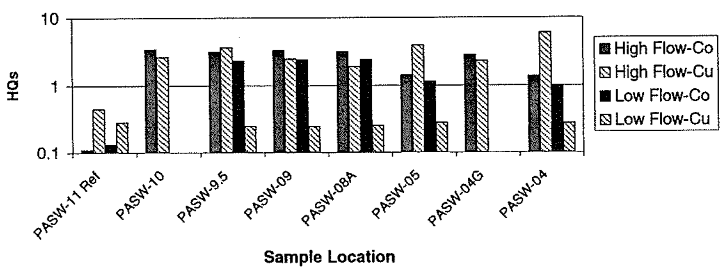


Overall Summary

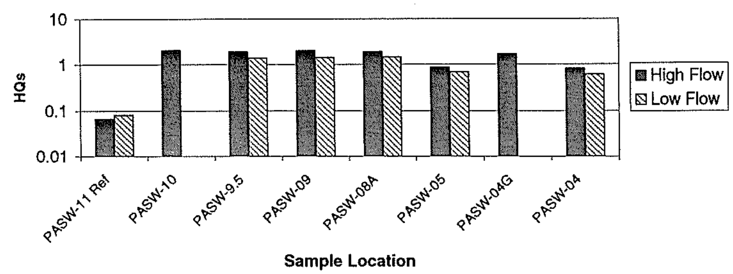
All the lines of evidence indicate that Blackbird Creek is potentially adversely affecting the aquatic ecosystem. Surface water HQs for the protection of aquatic life and salmonids are consistently greater than 10 for copper and cobalt during high flow. During low flow, HQs are occasionally less than 10, but are generally also greater than 10 for both copper and cobalt. The sediment HQs, subtracting background conditions, are greater than 10 for arsenic. For copper and cobalt the sediment HQs are only slightly greater than 1. The dietary HQs for copper and arsenic based on sediment uptake ranged from 7 to 12 for copper and 4 to 8 for arsenic. The benthic community data also indicate that there is the potential for adverse effects to the aquatic system since the downstream station does not resemble the reference station. However, there has been an improvement in the water quality and benthic community with the implementation of Early Actions.

Figure ES-4
Summary of Risk Characterization for Panther Creek (2000)

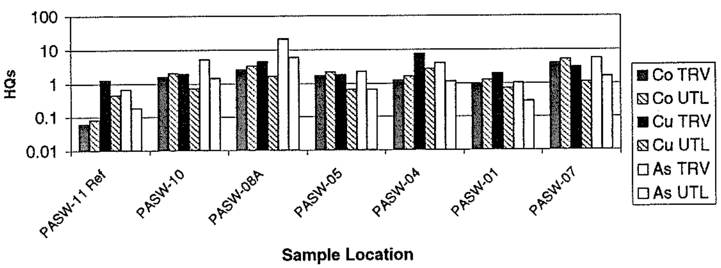
Chronic SW HQs for Protection of Aquatic Life for Cobalt and Copper (High Flow/Low Flow)



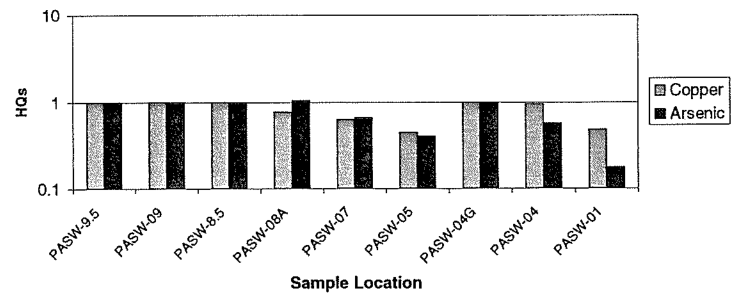
Chronic SW HQs for Protection of Salmonid - Cobalt Only



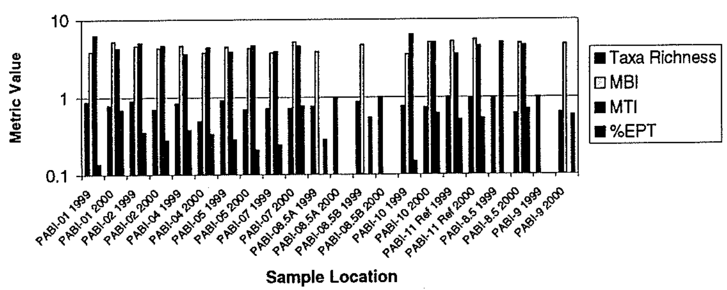
Comparison of Sediment HQs based on TRVs and Background (Protection of Benthic Invertebrates)



Dietary HQs



Benthic Invertebrate Community Summary 1999/2000

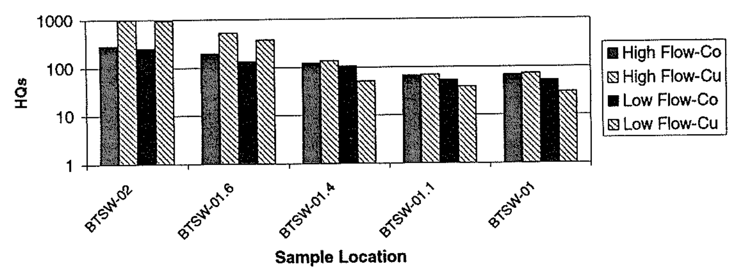


Overall Summary

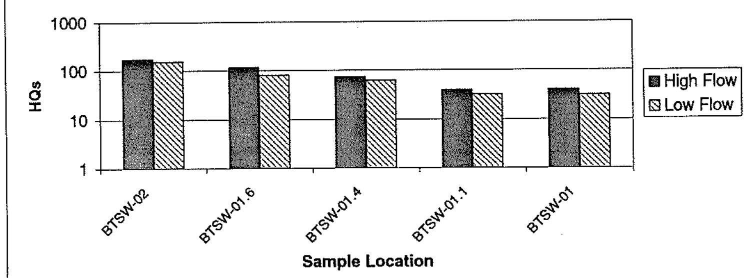
Panther Creek has shown significant improvements in water quality with the implementation of the Early Actions. The lines of evidence reflect this improvement; however, there is still potential for adverse effects to the aquatic ecosystem. Chronic and acute surface water HQs for copper during high flow range from 2 to 6. During low flow, surface water HQs are less than 1 for copper, indicating low potential for adverse effects during this period. Surface water HQs for cobalt range from 1 to 3 during both high and low flow periods for the protection of aquatic life. Based on protection of the salmonids, HQs range from less than 1 to 2. Sediment HQs, subtracting background conditions, are generally less than 1. The highest HQs in sediments are found at station PASW-08A where the HQs are 6, 3, and 2 for arsenic, cobalt, and copper, respectively. The dietary HQs based on the uptake of sediments for copper were less than 1 to 3 and less than 1 to 4 for arsenic. The benthic data along Panther Creek have shown improvement since the implementation of Early Actions. The benthic stations along Panther Creek are beginning to resemble the Panther Creek reference station. Panther Creek stations appear to have the healthiest communities compared to the other creeks that were sampled.

Figure ES-5
Summary of Risk Characterization for Bucktail Creek (2000)

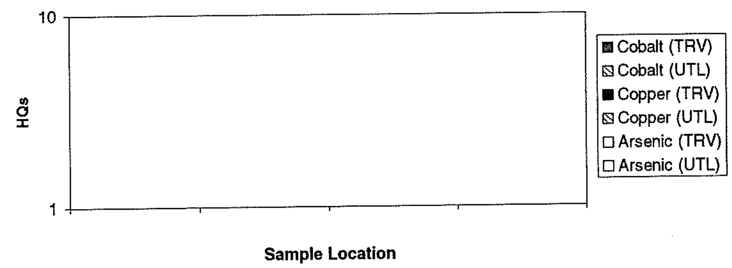
Chronic SW HQs for Protection of Aquatic Life for Cobalt and Copper (High Flow/Low Flow)



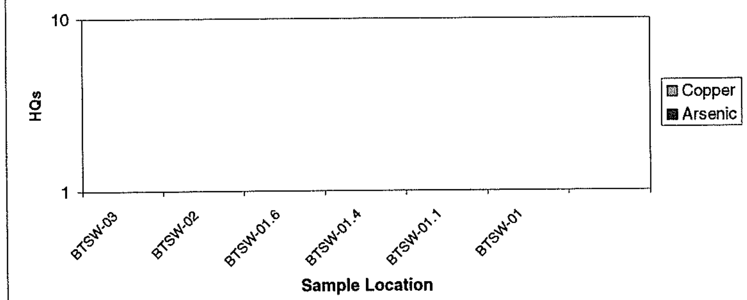
Chronic SW HQs for Protection of Salmonid - Cobalt Only



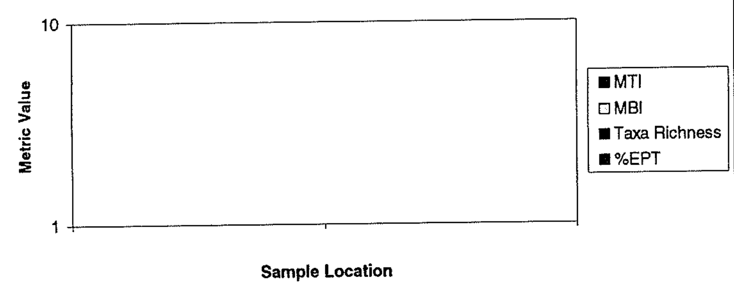
Comparison of Sediment HQs based on TRVs and Background (Protection of Benthic Invertebrates)



Dietary HQs



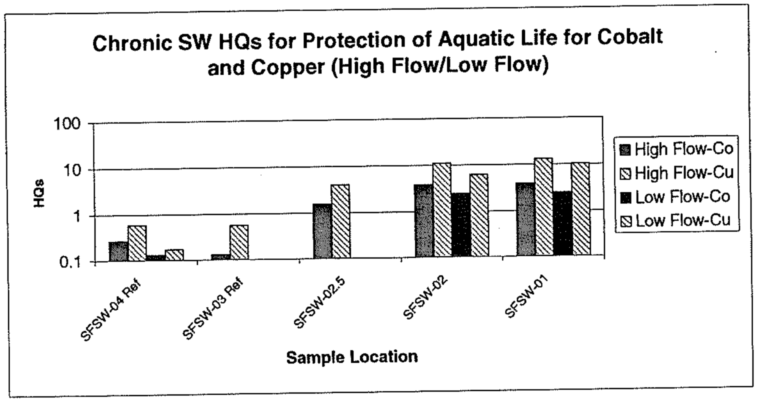
Benthic Invertebrate Community Summary 1999/2000

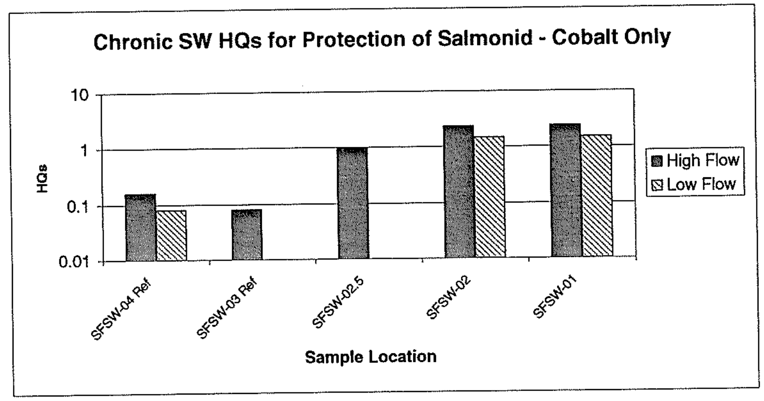


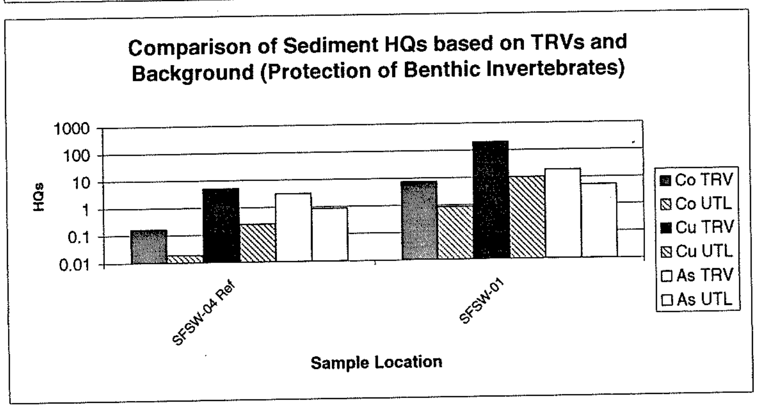
Overall Summary

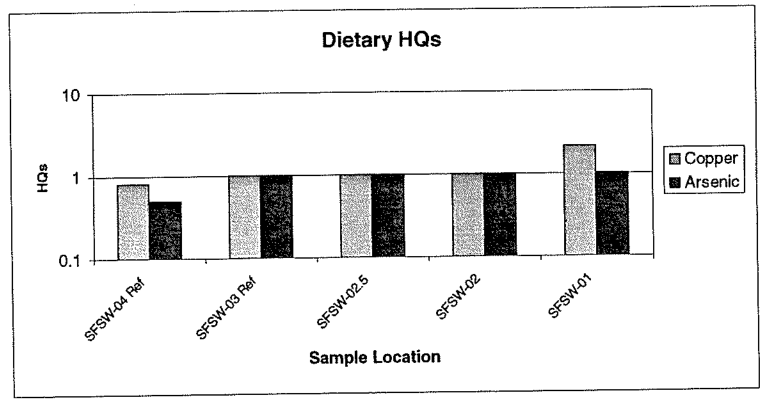
Bucktail Creek continues to have poor water quality. HQs for surface water are the highest along this creek and range to over 2000 for copper. The ecological management goal for Bucktail Creek was to provide food for fish in downgradient areas if they drift downstream. Based on the limited habitat conditions, and the low contribution of benthic invertebrates from Bucktail to the overall food supply in the drainage, it has been determined that Bucktail does not contribute significantly to the overall achievement of the ecological management goals.

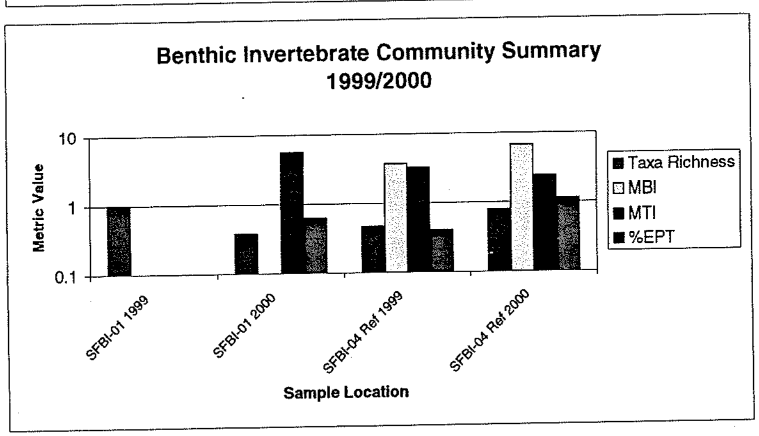
Figure ES-6
Summary of Risk Characterization for South Fork of Big Deer Creek (2000)







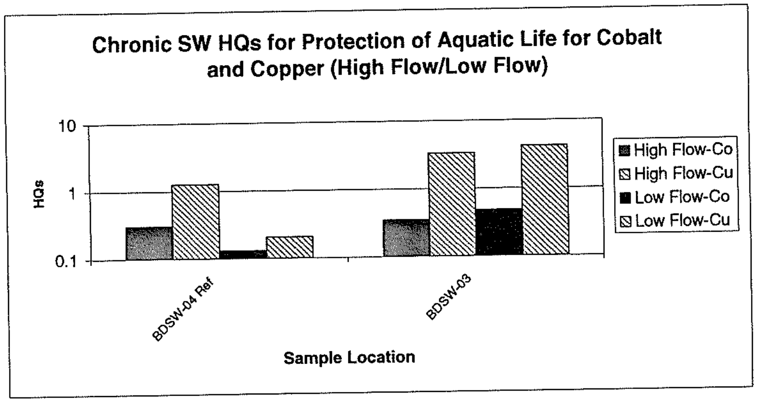


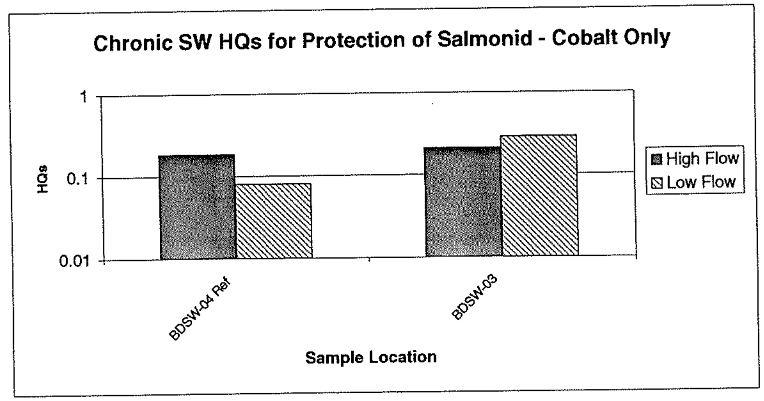


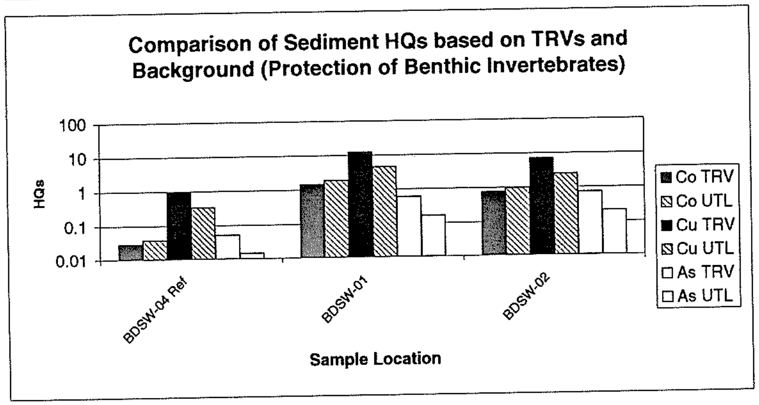
Overall Summary

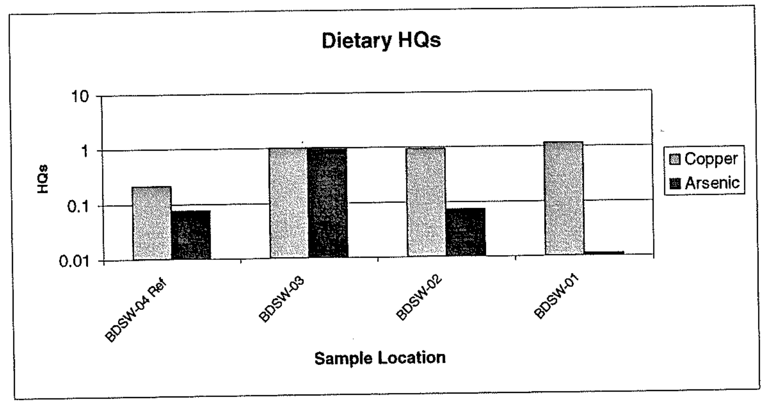
The lines of evidence for the South Fork of Big Deer indicate there is continued potential for adverse affects. Surface water HQs for copper range from 4 to 66 during high flow and up to 13 during low flow. Surface water HQs protective of aquatic life range from 2 to 9 during high flow and from 2 to 4 during low flow. Surface water HQs for the protection of salmonids are low, with a maximum HQ of 2 in 2000. Surface water HQs are lower in 2000 than 1999; this may reflect continued improvements due to implementation of Early Actions. Sediment HQs, subtracting background conditions, are 5 for arsenic and 10 for copper. The dietary HQs based on sediment uptake range from less than 1 to 2 for copper and are 1 or less for arsenic. The data indicate the benthic community along South Fork of Big Deer Creek continues to be impacted, with most of the indices evaluated at the downstream stations not resembling the reference station.

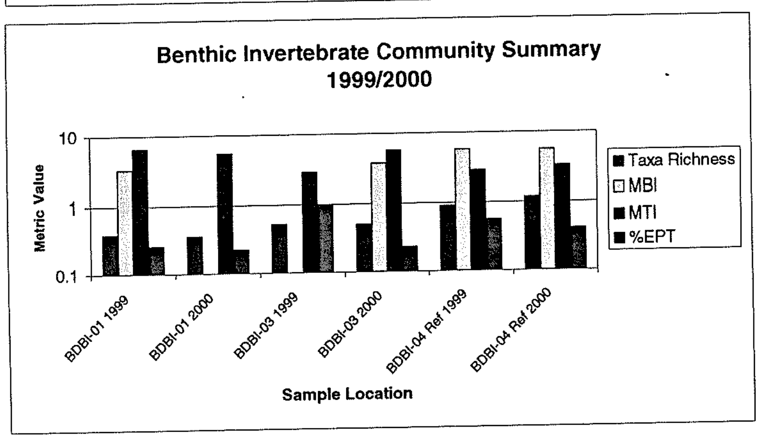
Figure ES-7
Summary of Risk Characterization for Big Deer Creek (2000)







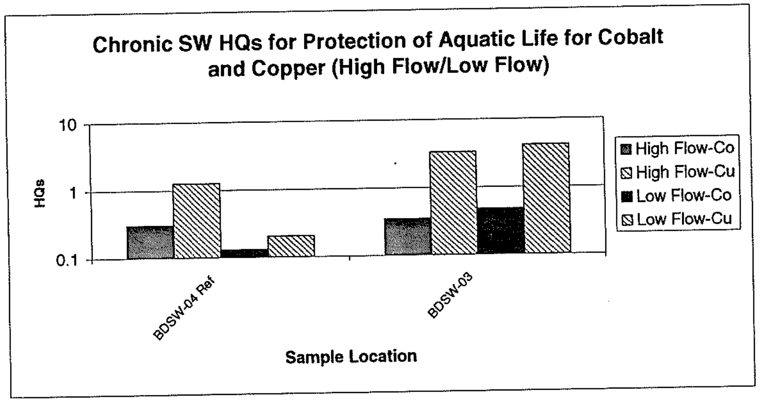


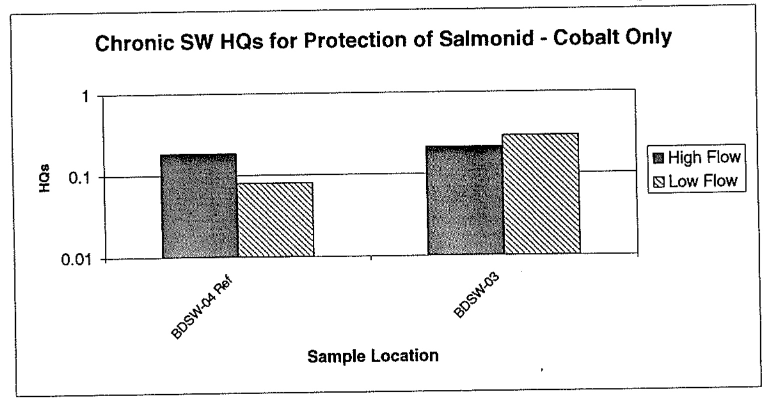


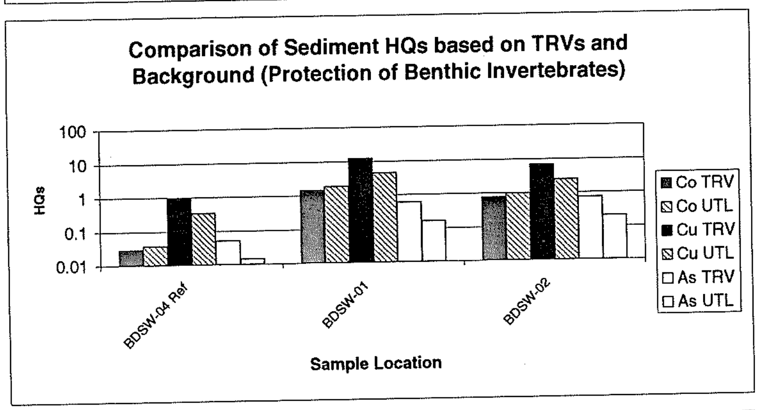
Overall Summary

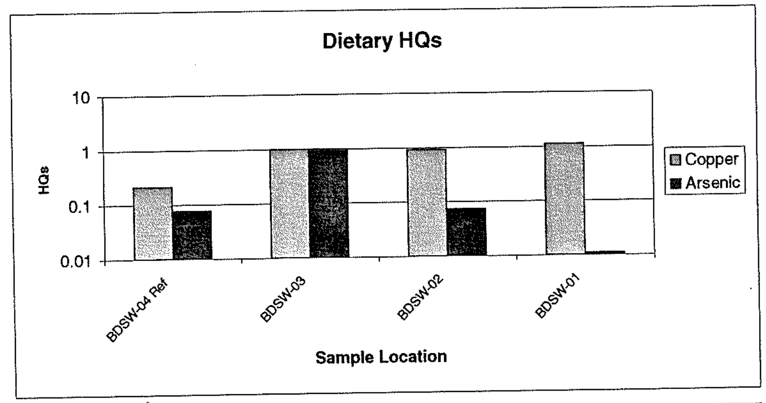
The lines of evidence for Big Deer Creek indicate some improvements in water quality. Surface water HQs for copper improved between 1999 and 2000 and ranged from 2 to 4. The improvement in surface water HQs between 1999 and 2000 may reflect the implementation of Early Actions. Surface water HQs for cobalt were below 1 for all the sampling events, indicating low potential for adverse affects due to cobalt. Sediment HQs, subtracting background conditions, ranged from 2 to 4 for copper and were 2 for cobalt. Sediment HQs for arsenic and iron were less than 1. The dietary HQs based on sediment update are 1 or less. The benthic community data are beginning to resemble the reference station for several indices. Based on the low dietary HQs and the uncertainty associated with establishing background UTLs for Big Deer Creek, it is unlikely that sediments are causing potential adverse effects to the aquatics system. The surface water HQs for copper, where there is less uncertainty, indicate the potential for continued adverse affects.

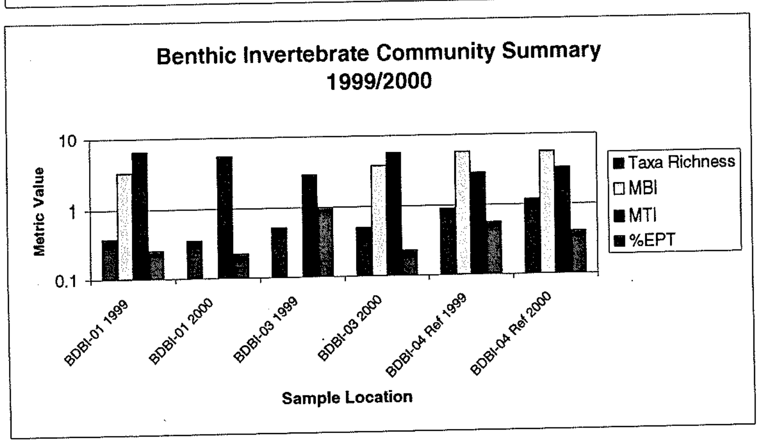
Figure ES-7
Summary of Risk Characterization for Big Deer Creek (2000)











Overall Summary

The lines of evidence for Big Deer Creek indicate some improvements in water quality. Surface water HQs for copper improved between 1999 and 2000 and ranged from 2 to 4. The improvement in surface water HQs between 1999 and 2000 may reflect the implementation of Early Actions. Surface water HQs for cobalt were below 1 for all the sampling events, indicating low potential for adverse affects due to cobalt. Sediment HQs, subtracting background conditions, ranged from 2 to 4 for copper and were 2 for cobalt. Sediment HQs for arsenic and iron were less than 1. The dietary HQs based on sediment update are 1 or less. The benthic community data are beginning to resemble the reference station for several indices. Based on the low dietary HQs and the uncertainty associated with establishing background UTLs for Big Deer Creek, it is unlikely that sediments are causing potential adverse effects to the aquatics system. The surface water HQs for copper, where there is less uncertainty, indicate the potential for continued adverse affects.

Panther Creek

Panther Creek has shown significant improvements in water quality with the implementation of the Early Actions. The lines of evidence reflect this improvement; however, there is still potential for adverse effects to the aquatic ecosystem (Figure ES-4). Chronic and acute surface water HQs for copper during high flow range from 2 to 6. During low flow, surface water HQs are less than 1 for copper, indicating low potential for adverse effects during this period. Surface water HQs for cobalt range from 1 to 3 during both high and low flow periods for the protection of aquatic life. Based on protection of the salmonids, HQs range from less than 1 to 2. Sediment HQs for all metals ranged between 1 and 21, and metal concentrations were less than 1 to 6 times higher than background. The highest metal concentrations above background in sediments were found in station PASW-08A. The dietary HQs based on the uptake of sediments for copper were less than 1 and less than 1 to 4 for arsenic. The benthic data along Panther Creek have shown improvement since the implementation of Early Actions. The benthic stations along Panther Creek are beginning to resemble the Panther Creek reference station. Panther Creek stations appear to have the healthiest communities compared to the other creeks that were sampled.

The comparison to background, the surface water and sediment HQs, and the benthic community data suggest continuing effects on the aquatic ecosystem, although improvement has been observed due to implementation of Early Actions.

Bucktail Creek

Bucktail Creek continues to have poor water quality (Figure ES-5). HQs for surface water are the highest along this creek and range to over 2000 for copper. The ecological management goal for Bucktail Creek was to provide food for fish in downgradient areas if they drift downstream. Based on the limited habitat conditions, and the low contribution of benthic invertebrates from Bucktail to the overall food supply in the drainage, it has been determined that Bucktail does not contribute significantly to the overall achievement of the ecological management goals.

South Fork of Big Deer Creek

The lines of evidence for the South Fork of Big Deer indicate there is continued potential for adverse affects (Figure ES-6). Surface water HQs are lower in 2000 than 1999; this may reflect continued improvements due to implementation of Early Actions. Surface water HQs for copper range from 4 to 66 during high flow and up to 13 during low flow. Surface water HQs protective of aquatic life range from 2 to 9 during high flow and from 2 to 4 during low flow. Surface water HQs for the protection of salmonids range from less than 1 to a maximum HQ of 2 in 2000. Sediment HQs ranged from less than 1 to 203. Arsenic concentrations were five times higher than background conditions, and copper concentrations were 10 times higher than background conditions. The dietary HQs based on sediment uptake range from less than 1 to 9 for copper and are 3 or less for arsenic. The benthic community data along South Fork of Big Deer Creek continues to be impacted, with most of the indices evaluated at the downstream stations not resembling the reference station.

Big Deer Creek

The lines of evidence for Big Deer Creek indicate some improvements in water quality (Figure ES-7). Surface water HQs for copper improved between 1999 and 2000 and ranged from 2 to 4. The improvement in surface water HQs between 1999 and 2000 may reflect the implementation of Early Actions. Surface water HQs for cobalt were below 1 for all the sampling events, indicating low potential for adverse affects due to cobalt. Sediment HQs ranged from less than 1 at the reference station to 12 at BDSW-01 for copper; HQs for arsenic, iron, and cobalt were less than 1 at the reference location and downgradient areas. Cobalt sediment concentrations were two times higher than background, and copper sediment concentrations were four times higher than background. The dietary HQs based on sediment uptake are l or less. The benthic community data is beginning to resemble the reference station for several indices. Based on the low dietary HQs and the uncertainty associated with establishing background UTLs for Big Deer Creek, it is unlikely that sediments are causing potential adverse effects to the aquatics system. The surface water HQs for copper, where there is less uncertainty, indicate the potential for continued adverse affects.

Geochemical Modeling

Geochemical modeling that was performed as part of the RI by Golder (2001) indicates that metals will be released from instream sediments through a combination of dissolution and desorption. Water quality will vary over time due to these mechanisms; however, over time, the dissolved metals concentrations will ultimately decline as cleaner water is transported over the metal-bearing sediments. Temporary increases in aqueous metal concentrations may be seen over a period of time due to a combination of pH effects and competitive adsorption (Golder, 2001). As dissolved metals increase over the near term, HQs will also increase for these metals. In South Fork Big Deer, trace metal release from sediments is believed to be responsible for the current observed increases in copper and sulfate concentrations between SFSW-02 and SFSW-01. Copper carbonate dissolution is believed to be the primary mechanism responsible for copper loading. Sulfate loading is likely the result of desorption or sulfate mineral dissolution. Sequential extraction results for South Fork Big Deer indicate that only half the total sulfur is present as primary sulfides. Labile sulfur is therefore present in the sediments in this creek. Desorption from iron and manganese (oxy) hydroxides in Big Deer and Panther Creeks may result in some dissolved metal increases as well. However, the desorption process indicates a gradual release of metals as new equilibrium is reached between the aqueous and adsorbed phases. Trace metal release due to desorption is also predicted to occur from Blackbird Creek sediments. The portion of total metals present as primary sulfides in this creek, likely from a tailings source, is not expected to be a significant source of trace metal loading.

Tailing Deposits along Blackbird Creek

Tailing deposits along Blackbird Creek also are of concern from a remobilization/ recontamination standpoint in Blackbird Creek and Panther Creek due to eposicatic loading (major storm events). In addition, if large sediment loads enter the stream from these deposits, there is the potential of loadings of fines into the stream that could produce a physical hazard as well as a chemical hazard to salmonids.

Summary

The Early Actions have significantly improved water and sediment quality at the Blackbird Mine. However, the overall conclusion of the AERA is that copper and cobalt remain in the aquatic environment at concentrations likely to produce adverse effects in the aquatic ecosystem. That continuing adverse effects are occurring is supported by the benthic macroinvertebrate data, which indicate little similarity to that of the stream-specific reference location for many impacted locations. The data suggest limited, but not complete, recovery in Panther Creek, and little recovery at the other locations.

Remedial Action Objectives and Preliminary Remediation Goals for the Blackbird Mine Site

Prepared for

United States Environmental Protection Agency
Region 10, Idaho Operations

Prepared by

CH2MHILL

September 7, 2001

TABLE 5-8
Sediment PRGs for Panther Creek

COPEC	Background UTL (mg/kg)	TEC TRV (mg/kg)	Dietary PRG (mg/kg)	PEC (mg/kg)	PRG (mg/kg)
Arsenic	34.8	9.79	76.29	33	34.8
Cobalt	39	50	No TRV; PRG cannot be determined	Cannot be determined; site-specific data suggest 80.3	80
Copper	87	31.6	536.5	149	149

Note: all values are in mg/kg dry weight

5.3.4 Aquatic Life PRGs for Surface Water in Panther Creek

This section describes the toxicity criteria and exposure assumptions used to calculate the surface water PRGs for the protection of aquatic life in Panther Creek. Maximal estimates of exposure produced excess risks for all COPECs. Aquatic receptors consisting of anadromous and resident salmonids, benthic invertebrates, and non-salmonid fish could inhabit Panther Creek in the absence of metal contamination. Consequently, surface water PRGs for aquatic life were established for Panther Creek. These surface water PRGs are the same as those established for Blackbird Creek (Table 5- 5).

5.4 Bucktail Creek

Bucktail Creek continues to have very poor water quality as a result of metal contamination. The ecological management goal in the AERA for Bucktail Creek was to have sufficient water quality in order to provide food for fish in downgradient areas based on invertebrate drift downstream. Based on the limited habitat conditions, and the low contribution of benthic invertebrates from Bucktail to the overall food supply in the drainage, it was determined that Bucktail Creek does not contribute significantly to the overall achievement of the ecological management goals in more ecologically important streams such as Big Deer Creek and Panther Creek. However, loading from Bucktail Creek into other streams needs to be minimized so that the PRGs for other streams are not exceeded due to episodic loading events from Bucktail Creek.

5.5 South Fork of Big Deer Creek

No soil PRGs were developed for human health or terrestrial receptors.

5.5.1 Aquatic Life PRGs for Instream Sediments along South Fork of Big Deer Creek

This section describes the toxicity criteria and exposure assumptions used to calculate the sediment PRGs for the protection of aquatic life in South Fork of Big Deer Creek. Benthic invertebrates dwell within the sediments and form the basis of the aquatic food web. Salmonids and other fish lay eggs in sediments. Metals are known to be toxic to benthic invertebrates, and may be toxic to salmonid eggs. Resuspended sediments serve as a potential source of exposure because fish and invertebrates can then ingest them from the water column during feeding.

Sediments produced excess risks for arsenic, cobalt, and copper, but not for iron. Aquatic receptors consisting of resident salmonids, other fish, and benthic invertebrates could inhabit South Fork of Big Deer Creek in the absence of metal contamination. Consequently, sediment PRGs for aquatic life were established for South Fork of Big Deer Creek by considering bioaccumulation, toxicity, and background conditions.

Benthic invertebrates can bioaccumulate metals from sediments, and contaminated invertebrates then serve as a food source and exposure pathway for salmonids and other fish. PRGs based on dietary ingestion were developed from site-specific data collected by RCG Hagler Bailly et al. (1994), and are described in Section 5.2.3. The dietary PRGs are the same as those developed for Panther Creek.The toxicity-based TRVs and the PECs are also the same as those used to develop PRGs for Panther Creek. The sediment UTLs, however, are higher than those proposed for Panther Creek.

The recommended PRGs are presented in Table 5-7. Background concentrations were given the highest weight in establishing the PRGs in that if the background UTL falls above the toxicity-based PEC or dietary PRG, the UTL is the recommended PRG. If the UTL falls below the PEC or dietary PRG, the PEC was the recommended PRG. The pre-mining background level will never be known with certainty, and the UTL is the best estimate of historical conditions that can be made with the available data. As discussed previously, the toxicity-based PEC is considered more defensible than the TEC.

The proposed arsenic PRG is slightly above, but approximates the corresponding PEC value. The PEC is a concentration above which adverse effects are likely to occur to benthic invertebrates, and presumably fish eggs and small fish dwelling near the surface water/sediment interface. The differences between the arsenic PEC and the PRG are likely *de minimus*, meaning they are essentially the same value. The cobalt and copper PRGs are based on the mineralized background UTL.

TABLE 5-7
Sediment PRGs for South Fork of Big Deer Creek

COPEC	Background UTL (mg/kg)	TEC TRV (mg/kg)	Dietary PRG (mg/kg)	PEC (mg/kg)	PRG (mg/kg)
Arsenic	34.8	9.79	76.29	33	34.8
Cobalt	436	50	No TRV; PRG cannot be determined	Cannot be determined; site-specific data suggest 80.3	436
Copper	637	31.6	536.5	149	637

Note: all values are in mg/kg dry weight

5.5.2 Aquatic Life PRGs for Surface Water along South Fork of Big Deer Creek

This section describes the toxicity criteria and exposure assumptions used to calculate the surface water PRGs for the protection of aquatic life for South Fork of Big Deer Creek. Maximal estimates of exposure produced excess risks for copper and cobalt, although a trend of decreasing excess risk over time is observed for this stream. Aquatic receptors consisting of resident salmonids, other small fish, and benthic invertebrates could inhabit South Fork of Big Deer Creek in the absence of metal contamination. Consequently, surface water PRGs for aquatic life were established for the South Fork of Big Deer Creek. These PRGs are the same as those derived for Blackbird Creek (Table 5-5).

5.6 Big Deer Creek

No soil PRGs were developed for human health or terrestrial PRGs.

5.6.1 Aquatic Life PRGs for Instream Sediments along Big Deer Creek

This section describes the toxicity criteria and exposure assumptions used to calculate the sediment PRGs for the protection of aquatic life in Big Deer Creek. Benthic invertebrates dwell within the sediments and form the basis of the aquatic food web. Salmonids and other fish lay eggs in sediments. Metals are known to be toxic to benthic invertebrates and may be toxic to salmonid eggs. Resuspended sediments serve as a potential source of exposure because fish and invertebrates can then ingest them from the water column during feeding.

Maximal estimates of exposure produced excess risks for arsenic, cobalt, and copper, but not for iron. Aquatic receptors consisting of resident salmonids, other small fish, and benthic invertebrates could inhabit Big Deer Creek in the absence of metal contamination. Consequently, sediment PRGs for aquatic life were established for Big Deer Creek by considering bioaccumulation, toxicity, and background conditions.

Benthic invertebrates can bioaccumulate metals from sediments, and contaminated invertebrates then serve as a food source and exposure pathway for salmonids and other fish. PRGs based on dietary ingestion were developed from site-specific data collected by RCG Hagler Bailly et al. (1994) and are described in Section 5.2.3.

The toxicity-based PEC is also the same as those used to develop PRGs for Panther Creek. The dietary PRGs for Big Deer Creek are higher than the toxicity-based PEC.

Background concentrations were given the highest weight in establishing the PRGs in that if the background UTL was above the toxicity-based PEC or dietary PRG, the UTL was the recommended PRG. If the UTL fell below the PEC or dietary PRG, the PEC is the recommended PRG. The pre-mining background level will never be known with certainty, and the UTL is the best estimate of historical conditions that can be made with the available data. Big Deer Creek is not in the naturally mineralized area; however, some historical input to Big Deer Creek was likely.

The recommended PRGs are presented in Table 5-9.